

	<p align="center"><b>Krueger International</b></p> <p align="center"><b>Re-Engineered Assembly Process and Replaced Solvent-based Glues with Water-based Glues</b></p>
<p><b><i>Standard Industrial Classification (SIC)</i></b></p>	<p>2522</p>
<p><b><i>Type of Waste</i></b></p>	<p>NR-445 Hazardous Air Pollutants, Volatile Organic Compounds, Particulates, Spent Primer Solvent, Spent Adhesives, and Spent Cleanup Solvents.</p>
<p><b><i>Strategy</i></b></p>	<p>Two primary pollution prevention techniques were adopted: Material substitution and technology changes.</p> <p>Krueger International's (KI) partner in this effort is HB Fuller Company who formulated a new environmentally friendly glue for KI's manufacturing processes at KI's request. The new glue required the design and installation of new ventilation capture and control equipment as well as a delivery system of piping, pumps, and sophisticated HVLP spray guns.</p>
<p><b><i>Company Background</i></b></p>	<p>KI began operations in 1941 in Aurora, Illinois and was established primarily to offer the marketplace with a high value, competitively priced folding chair. Today, KI is headquartered in Green Bay and has several manufacturing facilities throughout the US and abroad, employing approximately 3,147 people. At its Green Bay location, KI manufactures executive, secretarial, and stacking chairs, airport seating, university seating, theater seating, parts of tables, and dollies to store tables and stacking chairs. From its beginnings producing a steel folding chair, KI now produces complex office furniture systems world wide.</p>
<p><b><i>Original Process</i></b></p>	<p>Five different solvent based glues were used to join various furniture parts made of plastic, wood, fabric, and metal. Some of the plastic seating had to be dipped in a vat containing a flexible primer solvent. The solution altered the surface of the substrate which facilitated proper bonding of foam to plastic or fabric to plastic. All the solvent based glues were easy to use and the process did not require sophisticated equipment or skill to apply. The glue, once applied to the substrates, was very forgiving and allowed for operators to readjust materials as needed without compromising the bond of the glue. Petroleum based solvents were used to clean up overspray on products when needed. Spent solvents and flexible primer were disposed of and fuel blended through a hazardous waste company.</p>
<p><b><i>Motivation</i></b></p>	<p>KI was concerned about ozone depleting chemicals (VOCs), and hazardous air pollutants being released into the environment as well as potential employee exposure to hazardous materials. The Vice President of Operations wanted KI to stand out as an environmental leader in the industry which is in keeping with the culture of the company. KI's customers were now demanding to do business with companies that have proven environmental success strategies and records. KI also wanted to redirect time and money currently spent on personal protective equipment, training, industrial hygiene monitoring, air and waste charges to other</p>

	useful environmental/safety and health projects.
<b><i>Pollution Prevention Process</i></b>	<p>All petroleum solvent based glues were replaced with water based glues. The bonds obtained using the new glue eliminated the need to pre-treat plastic with a flex primer previously needed to obtain a good bond, and petroleum based solvents used for cleanup were replaced with water. The new two-component water based glues require a special gun that sprays an activator which meets the glue in mid-stream outside the gun causing the glue to coagulate instantly. Rather than relying on solvent evaporative drying, water is driven out of the assembled product one of two ways depending on the needs of the product and process. The first and most frequently used process requires the assembled parts to be pre-heated under an infrared oven following the application of adhesive and assembly. Once partially assembled, the glued part is put into a heated vacuum press in which most of the remaining water is driven out of the product. The second method involves spraying each substrate with adhesive, and allowing it to air dry in racks before partial assembly. After the water dries off each substrate, the substrates are laid over each other and placed into a heated vacuum press which reactivates the adhesive. New stainless steel piping and pumping systems were also required to convey the glue as well as ten new ventilation systems to properly capture and control the new adhesive.</p> <p>The glues are shipped in reusable totes that are dedicated to the KI facility. The empty totes are picked up and cleaned by the vendor and are then refilled and shipped to KI.</p>
<b><i>Stage of Development</i></b>	The water based glue called HydropHuse is in full use at the KI plants in Green Bay.
<b><i>Level of Commercialization</i></b>	The glue was specifically developed for KI, however, it is now available and being used by six other businesses in Wisconsin, three on the west coast, and one internationally. Two additional adhesives modeled after the glue that KI pioneered are currently used by other companies.
<b><i>Obstacles</i></b>	<p>The new glue was not compatible with the existing ventilation systems because of larger particle sizes and increased solids content. Initial problems with the products included mold growth, fabric wrinkling, and color bleed through. Later KI incurred problems with cellular foam collapse which required developing another lower-tack water-based glue.</p> <p>Use of the new system required extensive training, especially during the early phases of the process change.</p> <p>On most product lines, the substrates are heated before the glue is applied using expensive infrared ovens and later placed into a heated vacuum press to dry and activate the glue. Before using the infrared ovens, we experienced a delay in the assembly process time.</p>
<b><i>Material/Energy Balance</i></b>	<p>The new process uses materials much more efficiently.</p> <p>The old glues ranged from 15-20% glue and 80-85% solvents, while the new glues are 52% glue and 48% water. So, the new glues contain twice as much adhesive per gallon than the old glue. The Spray gun efficiency</p>

	increased by 28% with the new process			
<i>Economics</i>	<b>Capital Costs</b>	<b>Description</b>	<b>Cost</b>	
	New Equipment and installation	Glue Booths, Spray Guns, Infrared Ovens	\$222,978.00	
		Total Capital Costs	\$222,978.40	
	<b>Operating Costs Explanation</b>  1. In addition to annual maintenance, the anticipated VOC emission control equipment would have a start up cost of <b>\$1,494,000.00</b> . 2. Money was saved by avoiding permit costs, regulatory paperwork, employee exposure issues, and industrial hygiene testing.			
<i>Benefits</i>	KI went from being rated a major pollution source to a synthetic minor.			
	KI employees are working with materials which are significantly less toxic and hazardous. The glue booth environments exceed OSHA health requirements.			
	KI reduced VOC emissions 81.9% from 1994 to 1996.			
	KI reduced NR-445 hazardous air pollutants 92.4% or 37 tons/year from 1994 to 1996.			
	KI reduced its particulate matter emissions by 73.72% from 1994 to 1996.			
	KI is able to increase its capacities of production without the need for sophisticated and expensive control equipment. Spray gun efficiencies increased from 50% to 78%.			
	<b>Operating Costs</b>	<b>Description</b>	<b>Cost Old Process</b>	<b>Cost New Process</b>
Material	Flexi-Primer & labor	\$62,242.29/yr	0	\$62,242.29/yr
Labor	equipment maintenance	\$12,180.00/yr	\$65,520.00/yr	(\$53,340.00)/yr
Maintenance	Hardware replacement	\$887.69/yr	\$12,607.93/yr	(\$11,720.24)/yr
Equipment Training		\$432.33/yr	\$13,834.80/yr	(\$13,402.00)/yr
Waste Handling	Disposal of cleanup solvents, primer solvent, and spoiled glue	\$6,300/yr	\$0	\$6,300.00/yr

	Transportation of wastes	Disposing of glue barrels	\$2,400/yr	\$0	\$2,400/yr
	Anticipated VOC emission control equipment		\$829,100	\$0	\$829,100/yr
	Total Savings				\$821,580.00/yr
	<p>Redesign to the ventilation systems increased capture and control efficiencies from 82% to 99.99%.</p> <p>The totes used for transporting glue are no longer disposed of but are reused.</p>				
<b>Technology Transfer</b>	This technology is transferable and it is currently in use by other businesses throughout the US and abroad.				
<b>Other Environmental Programs</b>	<p>KI's electroplating department has received major Pollution Prevention (P2) improvements including a hexavalent chrome process which is virtually closed-loop.</p> <p>Plastic pieces from off-spec products are ground up and reused at KI. Other plastic purging is collected and recycled offsite. As a result, 197,000 pounds of plastic were diverted from landfills in 1996, while KI netted nearly \$14,000 selling the plastic purging for recycling.</p> <p>Excess nylon sprus/runners used to hold parts in place in the injection mold are cut off with a small robotic arm and fed into a small regrinder for reuse. 18,000 pounds of nylon sprus/runners were recycled in this manner in 1996.</p> <p>KI has effectively worked with their suppliers to provide exact cut sizes of foam and fabric to avoid the need for trimming excess material. A new cutting machine now provides for precise layout cuts with waste reduction savings estimated at \$1 million.</p> <p>Several methods of recycling process water has cut KI's water consumption from 1,465,000 gallons per week to 680,000 gallons per week in 3 years.</p>				
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**Pollution Prevention Information Clearinghouse**

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